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I, LISA TREVERROW, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PQ 4054 for a patent by WILLIAM RODGERS AND ANTHONY KHOURI filed on 15 November 1999.

COMMONWEALTH OF AUSTRALIA
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WITNESS my hand this
Seventh day of November 2000

Lisa Treverrow

LISA TREVERROW
TEAM LEADER EXAMINATION
SUPPORT AND SALES

PRIORITY DOCUMENT

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PATENTS ACT 1990

PROVISIONAL PATENT SPECIFICATION

THE INVENTION IS DESCRIBED IN THE ACCOMPANYING STATEMENT:

VEHICLE MOUNTED PLASTICS DRUM FOR CONCRETE MIXING AND METHOD OF MANUFACTURE THEREOF

BACKGROUND

The present invention relates to concrete mixing apparatuses and more particularly relates to a vehicle mounted plastics drum for mixing concrete and a method manufacture thereof.

PRIOR ART

The building industry makes widespread use of concrete mixing trucks for transportation of ready mixed concrete to sites for concrete pours. These trucks typically comprise a large mixing assembly including a mixer drum mounted to the vehicle and which is connected to a mixer drive for mixing concrete contents during transporation and for discharge of the contents on site. The drive system comprises a gear box which takes power from the vehicle motor and which applies a mixing torque to the drum imparting axial rotation to the drum with the torque being adjustable depending upon the operating requirements. The above general arrangement is described in United States patent 4,585,356 which discloses a concrete mixer truck having a mixer drum adapted to be rotated by the traction motor of the vehicle through an auxiliary transmission of the traction motor transmission.

According to the known vehicle mounted mixing assemblies, the mixing drum is typically of heavy duty steel construction and is disposed at approximately 10 to 15 degrees from horizontal. The drum is fitted with internal vanes or mixing blades defining an archimedian spiral so that as the drum rotates in a first direction the concrete held therein is mixed and as the drum is rotated in the opposite direction, the concrete is discharged from the drum via an elevated discharge orifice under the reverse action of the internal spiral vanes. The drum is disposed such that the drive end is lowest and the discharge end is highest relative to a generally horizontal plane of the vehicle.

While steel drums have been in use for many years, they suffer from a number of attendant

disadvantages. relating to their cost of manufcture and replacement, working life, wear characteristics, weight and volume.

Steel drums are expensive to manufacture due to their labour intensive construction which involves rolling steel sheets into conical portions and cylinders which once fabricated are then welded to form the finished tank. The archimedian spirals formed from flat sheets are then welded into position inside the drum. As concrete is a highly abrasive material, internal surfaces of steel drums are subject to significant wear abrasion. This occurs particularly on the surfaces which take slump impact, sliding friction and shear load leading to eventual wearing out of the drum.

Typically, a steel drum used every day might last three to five years, thereafter requiring replacement at significant cost. The abrasion of internal surfaces is increased where there are changes of slope in the drum walls usually where the segments of the drum are joined.

The mixing blades are welded to the internal suface of the drum causing sharp angled recesses in which concrete can gather and eventually build up degrading the internal surface and providing a catchment for further unwanted build up of concrete. By its nature, a steel surface is relatively smooth and whilst this may be desirable for the purpose of preventing concrete build up on the walls of the drum, the interface between the concrete and steel wall is an area of abrasion rather than concrete mixing.

Ideally, mixing of concrete should take place throught the whole mix, but in the steel drums, optimum mixing does not take place at the boundary layer and in crevaces in which concrete may collect. In fact, due to the nature of the frictional interface between the steel surface and concrete boundary layer, laminar flow occurrs resulting in little or no mixing at the boundary layer. The reason for this is that the aggregrate in the concrete slides and abrades (with reduced

or no mixing) rather than rotates to facilitate mixing. Thus there are 'dead' spots in the mix where no mixing takes place and where there is an increased potential for unwanted collection of concrete. In addition to the above problems associated with the use of steel mixing drums, there are cost and weight factors which add to inherent inefficiencies in use of steel drums.

Due to the dead weight of the steel drum, its volume must be restricted so the combination of the dead weight and concrete weight must be maintained within the maximum allowable loading limits for the vehicle to which the drum is attached. The inventor to considered the possibility of using a lightweight material such as plastics for construction of a concrete mixing drum as a substitute for steel whilst recognising that there were numerous structural and manufacturing difficulties to be overcome in making the transition to plastics not the leaast of which was the production of a drum which could withstand the high static and dynamic loadings to which truck mounted mixing drums are subject to in normal operation. If the weight of the drum could be reduced without compromising and possibly increasing drum volume the weight reduction could be taken up with additional concrete thereby increasing the pay load.

There are variety of concrete mixing drum arrangements disclosed in the prior art none of which as far as the inventor is aware anticipate the arrangements to be described herein.

United States patent 4,491,415 discloses a lightweight, pear shaped rotary mixing device open at one end and having an axially elongated socket at the large end. The drum is rotatably supported on a unitary base having a transversely extended forward end and an upwardly and angularly extending rear end providing a bearing portion detachably engagable with the socket to rotatably support the drum at an inclination of about 35 degrees. The drum has a plurality of axially extending radial fins for lifting contents in rotation thereof and is preferably fashioned from moulded plastics material either as a unitary body or as a plurality of interfitting parts. The drum described in this patent is for light duty operation and does not have the structural and materials

characteristics necessry for heavy duty concrete mixing operations.

United States Patent 5,118,198 discloses a cement mixing apparatus with a cradle support assembly and including a polyethelyne cement mixing drum held and supported by a cradle arm assembly formed of cradle base support braces and upright cradle arms which interfit into cradle arm recesses which are preformed with the polyethylene drum. A bull gear drives the polyethylene drum. The drum disclosed in this patent is intended for light duty cement operations and does not address the structural and manufacturing requirements for heavy duty operations.

United States patent 5,492,401 discloses a concrete mixer with a mixing drum consisting of high density crosslinked polyethylene material. The drum includes a bottom supported buy a conventional rigid metal pan secured to the external surface thereof to rigidify the plastic drum and extend the life expectancy of the plastic drum by enabling the concrete mixer to be used to complete a mixing job at a job site even though movement of the concrete mix within the drum during repetitive mixing cycles may ultimately wear a hole through the bottom of the plastic drum. Paddle assemblies are positioned interiorly of the drum and oriented to maintain minimum splashing during the mixing operation. Not only is the drum disclosed in this patent unsuitable for heavy duty vehicle mounted operation the patent in fact teaches a means to accomodate a wear failure on site whereby a hole could be worn through the wall of the drum.

Whilst the prior art teaches use of plastics drums for small cement mixing operations it does not teach the use of such materials as a substitute for steel in heavy duty operations. Conventional wisdom suggests that use and manufacture of plastics concrete mixing drums for heavy duty operations such as vehicle mounted drum mixing is not advisable in view of the significant static and dynamic loadings to which the drum will be subject in normal operations.

<u>INVENTION</u>

The present invention seeks to provide an alternative vehicle mounted rotating cement or

concrete mixing drum fabricated from plastics materials which overcomes the aforesaid disadvantages of the prior art and which not only improves the concrete mixing characteristics but prolongs the life of the drum in comparison to its steel equivalent and allows an increase in concrete carrying capacity of the drum commensurate with the reduction in drum dead weight thereby resulting in an increase in pay load for potentially each vehicle journey and without breach of the boundary requirements of the vehicle.

In the broadest form of the apparatus aspect the present invention comprises;

a heavy duty rotary concrete mixing drum for attachment to a vehicle; characterised in that the drum is manufactured from at least one mould and from at least one plastics material and wherein the drum includes an inner surface having a property which promotes mixing of the concrete at the boundary layer between the concrete and said inner surface and reduces wear.

In one broad form of the apparatus aspect the present invention comprises:

a vehicle mounted rotary concrete mixing drum having an opening at one end for receiving and discharge of concrete therefrom and at the other end means for engaging a drive assembly so as to rotate the drum for mixing or discharging concrete; wherein, the drum is manufactured from at least one mould using at least one plastics material; wherein the drum further includes detachable or integrally attached vanes which outstand from the internal surface of the drum forming an archimedian spiral disposed such that when the drum is rotated in a first direction. the concrete contents are mixed and when the drum is rotated in a second direction the contents are discharges from said drum; and wherein the internal surface of the drum is formed or lined with an elastomer which causes mixing of the contents of the concrete at the concrete boundary layer; and wherein the weight of the drum is such that when full, the total weight of the drum and contents is lighter than for a steel drum of an equivalent size when full.

In another broad form of the apparatus aspect, the present invention comprises:

a vehicle mounted rotary concrete mixing drum having an opening at one end for receiving and discharge of concrete therefrom and at the other end means for engaging a drive assembly so as to rotate the drum for mixing and discharging concrete; wherein, the drum is manufactured from two or three moulds using at least one layer of plastics material; wherein the drum further includes detachable or integrally attached vanes which outstand from the internal surface of the drum forming an archimedian spiral disposed such that when the drum is rotated in a first direction. the concrete contents are mixed and when the drum is rotated in a second direction the contents are discharged from said drum; and wherein the internal surface of the drum comprises a polyurethane layer to enhance mixing of the contents of the concrete at the concrete boundary layer; and wherein the weight of the drum is such that when full, the total weight of the drum and contents is lighter than for a steel drum of an equivalent size when full.

In another broad form of the apparatus aspect, the present invention comprises:

a vehicle mounted rotary concrete mixing drum having an opening at one end for receiving and discharge of concrete therefrom and at the other end means for engaging a drive assembly so as to rotate the drum for mixing or discharging concrete; wherein, the drum is manufactured from two or three moulds and comprises a first plastics material such as woven fibreglass forming an outer surface of the drum and a second plastics material such as polyurethane or like elastomer forming an inner surface of the drum; wherein the outer and iner surfaces together form a wall of the drum and wherein the drum further includes detachable or integrally attached vanes which extend inwardly from the wall of the drum forming an archimedian spiral disposed such that when the drum is rotated in a first direction, the concrete contents are mixed and when the drum is rotated in a second direction the contents are discharged from said drum; and wherein the innner polyurethane surface of the drum provides wear resistance and enhances mixing of the contents of the concrete at the concrete boundary layer; and wherein the weight of the drum is

such that when full, the total weight of the plastics drum and contents is lighter than for a steel drum of an equivalent or smaller size when full.

According to one broad form of the method aspect, the present invention comprises; a method of manufacture of a vehicle mounted plastics rotatable concrete mixing drum comprising the steps of;

a) taking a first male mould part defining a part profile of said drum:

b) applying a release agent to an outer surface of said mould part;

c) applying over said release agent an elastomer in liquid form and allowing said elastomer to polymerise against the mould so as to form a first part of said drum;

d) taking second and third mould parts;

e) applying steps b) and c) to said second and third male mould parts to form second and third parts of said drum;

f) abutting a first end of said first drum part to a first end of said second drum part and abutting a second end of said second drum part to a first end of said third drum part;

g) applying a fibre reinforced composite to said elastomer in the regions of abutment of said first second and third drum parts to effect bonding of said drum parts;

h) applying a bonding agent to said elastomeric layer as a substrate to receive an outer layer of filament;

i) winding said filament about said drum to form an outer structural matrix.

According to another broad form of the method aspect, the present invention comprises; a method of manufacture of a vehicle mounted plastics rotatable concrete mixing drum comprising the steps of;

a) taking a first male mould part defining a part profile of said drum:

b) applying a release agent to an outer surface of said mould part;

c) applying over said release agent an elastomer in liquid form and allowing said elastomer to polymerise against the mould so as to form a first part of said drum;

d) taking a second male mould part;

e) applying steps b) and c) to said second male mould part to form a second part of said drum;

f) abutting one end of said first drum part to one end of said second drum part ;

g) applying a fibre reinforced composite to said elastomer in the regions of abutment of said first and second drum parts to effect bonding of said drum parts;

h) applying a bonding agent to said elastomeric layer as a substrate for an outer structural layer of filament;

i) winding said filament about said drum to form an outer structural matrix.

According to another broad form of the method aspect, the present invention comprises; a method of manufacture of a vehicle mounted plastics rotatable concrete mixing drum comprising the steps of;

a) taking a first male mould part defining an end profile part of said drum:

b) applying a release agent to an outer surface of said first mould part;

c) applying over said release agent an elastomer in liquid form and allowing said elastomer to polymerise against the mould so as to form a first end part of said drum;

d) taking second and third mould parts;

e) applying steps b) and c) to said second and third male mould parts to form second and third parts of said drum;

f) abutting a first end of said first drum part to a first end of said second drum part

g) applying a coupling layer to said elastomer in the regions of abutment of said first and second drum parts;

h) applying a structural layer over said coupling layer at least in the region of said abutment

i) abutting a second end of said second drum part to a first end of said third drum part;

j) applying a coupling layer to said elastomer in the regions of abutment of said second and third drum parts;

k) applying a bonding agent to said elastomeric layer as a substrate coupling layer to receive an outer structural layer of filament;

l) winding said filament about said drum to form an outer structural matrix.

According to a preferred embodiment, the drum is manufactured from three moulded parts two of which comprise end parts of the drum and a third comprising a central part for location between said end parts. Each mould part has a formation which imparts to the drum part formed by the mould part, a part spiral extending inwardly from the wall of the drum part such that when the drum parts are engaged together, an internal archimedian spiral is formed. The moulds are configured such that when the drum parts formed from the moulds are mated together, the internal archimedian spiral used for both mixing and discharge of concrete from the drum is complete.

Preferably, the outer mould surfaces are prepared with a release agent so the elastomer may be readily removed after curing. Preferably the elastomer is polyurethane and has a surface property which reduces abrasion yet enhances mixing.

Preferably there are three mould sections in which the junctions form part of the mixing spirals such that the sections are joined along the spirals.

The present invention will now be described according to a preferred but non limiting embodiment and with reference to the accompanying illustrations wherein:

Figure 1 shows a side elevation of a prior art mixing drum;

Figure 2 shows a side elevation of a cement mixing drum according to one embodiment of

the invention;

Figure 3 shows a cross section through the junction of two drum parts showing the join construction;

Figure 4 shows an enlarged view of the apex of the arrangement of Figure 3;

Figure 5 shows a section through the end of the drum showing a baffle plate inserted.

Figure 6 shows the drum of figure 2 including a cleaning spray head.

Figure 7 shows an enlarged view of the boundary layer wall /concrete interface in a steel concrete mixing drum; and

Figure 8 shows an enlarged view of the boundary layer wall / concrete interface in a plastics mixing drum according to a preferred embodiment of the invention.

Referring to figure 1 there is shown a side elevation of a known steel mixing drum 1 which is typically constructed from separate prefabricated sections 2, 3 and 4 which are welded together at seams 5, 6 and 7. At seams 5, 6 and 7 the welded joints which are subject to concentrated wear due to the change in surface direction at the join. The concentrated wear points in the prior art steel drums reduces the working life of the drums necessitating costly repair or replacement. Steel drums are fabricated from rolled flat sheets which form cones and a cylinder which are then joined together by welding. Archimedian spirals are then welded to the inner surface of the drum resulting in a high specific gravity vessel whose self weight limits the amount of concrete which can be carried by the vehicle to which it is attached. As previously indicated, the steel drums suffer from a number of disadvantages including susceptibility to abrasion at the junctions of the cylindrical and conical sections and the tendency for unwanted concrete build up at the sharp corners and crevaces formed by the mixing blades. In addition, the smooth internal surface of the steel drum promotes sliding abrasion and inhibits mixing at the boundary layer due to the low coefficient of friction at the interface.

Figure 2 shows the external profile of a concrete mixing drum 8 according to one embodiment of the invention. The drum is generally pear shaped and includes an opening 9 at one end for entry and discharge of concrete. The arrangement of figure 2 is arrived at following application of the method aspect of the invention herein described. Drum 8 is constructed from a fibre reinforced plastic structural shell with an elastomeric interior having a property which imparts abrasion resistance to the concrete but increases the mixing at the boundary layer of the concrete and drum wall by forced rotation of aggregate. According to a preferred embodiment drum 8 is constructed from three mould parts 10, 11 and 12in the following manner. A first mould part which will form an end of said drum is first coated with a release agent following which an elastomer which may be polyurethane is applied in liquid form to the outer surface of said first mould part and allowed to polymerise thereby forming an inner skin of an end part of said drum. These steps are repeated for production from corresponding moulds of the remaining drum parts 11 and 12 each of which has its own mould.

Whilst the embodiment described employs three mould parts it will be appreciated that the drum may be constructed from a lesser or greater number of parts. It has been found however, that a three part construction is preferable in view of the shape of the finished drum. Once the elastomeric wear resistant interior for each part is fashioned, each part is removed from its respective mould part following which the separate parts are joined. Initially the parts are abutted such that a portion of the archimedian spirals oppose to complete the spiral in the region of the join. In view of the separate drum parts there is a structural discontinuity which must be completed to eventually render the of the drum rigid and structurally sound. At the region of the joins, best shown in the example of Figure 3, there is an elastomeric layer 13 which forms the inner surface of the drum. At the join a coupling layer 14 is is applied over the elastomer following which a structural layer 15 is applied inside the convex recess 16 of the spiral section

17. This process is completed for each section of spiral at a join whereupon, a further coupling layer 18 is applied to the remainder of the outer surface of the drum over which is applied a structural layer 19 which is preferably a fibre reinforced composite to form a structural shell. The composite is applied by winding filament about the drum over the coupling layer 14 to form a fibreglass matrix with high strength properties sufficient to withstand normal operating loads applied during mixing and transporting concrete.

As a result of this construction, the spiral mixing blades inside the drum are hollow with high bending and shear resistance during mixing operations. The inner elastomeric surface is highly resistant to abrasion by concrete yet it is softer and lighter than the steel equivalent. The higher resistance to abrasion is facilitated by the natural elastic deformation of the elastomer which absorbs the kinetic energy of the concrete particles without gouging of the surface material. In addition, due to the property of the inner surface which will preferably be polyurethane, the concrete will be mixed rather than slide at the boundary layer ensuring efficient mixing of the concrete throughout the mix and reduction of abrasion due to the smooth curves throughout the interior of the drum. Figure 4 shows an enlarged cross sectional view of the extremity of the spiral section of figure 3. Included deep inside recess 16 is a continuous filament and resin 20. Figure 5 shows a cross section of an end region of a drum 21 including between spiral section 22 and wall 23 a baffle 24 imparting rigidity to the drum. The baffle plate is preferably glued into positions. Figure 6 shows a typical drum 25 according to a preferred embodiment of the invention including a spray head assembly 25. Figure 7 shows a cross section of a typical interface between a concrete mix 27 and a steel wall. Due to the inherent smoothness of the steel surface 28 the concrete tends to slide and abrade rather than mix. Figure 8 shows a cross section of a typical interface between a concrete mix 29 and an elastomeric boundary layer 30. As shown by arrows 31, the aggregate in the mix rotates due to the friction between concrete

29 and surface 30. The rotation avoids excessive abrasion of the surface 30 and enhances concrete mixing. Furthermore, as surface 30 is able to deflect energy is dissipated by the inherent elasticity of the surface contributing to the reduction in wear.

According to the preferred embodiment, the spiral blades inside the drum range between 1 metre and 2 metre pitch. At the drive end of the drum the spirals are approximately 2 metre pitch. The spiral blades are also formed by the elastomer which are reinforced by a fibre composite laid over a substrate coupling layer whereupon the mould halves are joined along the blade tips. A concave cavity formed by the blades at the apex of which is applied an elastomer to form a continuous surface with the rest of the elastomer along the sides of the blades. This internally reinforces the blades. The blades are reinforced by chopped strand, woven cloth or filament winding. The moulds may allow for a variety of helix pitches of the blades. Preferably, the radius of the root of the blade is is greater than 10mm to avoid unwanted accumulation of set concrete. Furthermore, the blades are strengthened by their moulding integrally with the wall of the drum and have a stiffness factor which will sustain all applied normal operating loads. In an alternative embodiment, the internal blades may be detachably fixed to the wall of the drum.

In an alternative embodiment, the elastomeric interior is enclosed by mould sections, the interior of which are laminated with fibre reinforced composite, the interiors of which has an unpolymerised liquid surface. The elastomeric interior is pressed against the interior of the moulds by inflation of the elastomeric shell and the pressure is maintained until the liquid composite cures. In this way a structural shell is formed in contact with the elastomeric interior. This dual material wall of the mixer has the chemical and abrasion resistance of the elastomeric interior as well as its boundary layer mixing ability for contact with the wet concrete and the structural strength and stiffness of the fibre reinforced composite to enable it to carry the loads of mixing

and transporting concrete. In further embodiment, the structural exterior shell is further strengthened by the process of filament winding which produces a structure with many times the strength and stiffness of random fibre composites.

At the drive end of the drum there is provided a steel ring which is moulded into the drum structure and proportioned to suit drive equipment. The arrangement is such that it will resist relative rotation between the ring and the fibre reinforced drum under applied torque.

The drum also comprises a track ring, which transmitts the vessel loading to the support rollers and is constructed from fibre reinforced plastic formed integral with the structural shell of the vessel. It is anticipated that the plastics drum will outlast its steel equivalent under the same working conditions by more than 10 years. The wall strength will be in the order of 600MPa at a thickness of approximately 8mm comprising approximately 3mm polyurethane and 5mm fibreglass winding. According to one embodiment, the elastomeric layers may be of contrasting colours to enable detection of wear spots.

A further advantage in the use of plastics for the mixing drums lies in the thermal properties of the plastics material. Hot conditions are undesirable for concrete mixing as they accelerate hydration reducing concrete workability which is an essential property required immediately following a concrete pour. In very hot climates, the conventional steel vehicle mounted mixing drums conduct high heat loads which increase heat at the concrete boundary layer due to contact with the super heated drum wall causing unwanted accelerated hydration. This phenomenon is difficult to avoid with steel drums as the conductivity of steel leads to high conductive heat transfer from the outer skin of the drum to the inner wall which is normally in contact with the concrete. In some hot climates, ice is placed in the steel drums in an attempt to arrest temperature increase inside the drum. As concrete hydration is an exothermic reaction, it is sensitive to external temperatures.

Accordingly it is desirable that the concrete temperature remains acceptably low to ensure a satisfactory level of workability and to retard hydration. Steel drums heat up significantly and conduct heat through their thickness making the concrete vulnerable to the vagaries of temperature variation. The inventor recognised that this is a problem to be avoided and has in accordance with one aspect provided a method of manufacture of a plastics drum to take the place of the conventional steel drums thereby reducing the unwanted effects of high thermal conductivity typical of the steel drums. The plastics drum allows the concrete to remain workable inside the drum for longer periods compared to concrete in steel mixing drums under the same external temperature conditions

It will be recognised by persons skilled in the art that numerous variations and modifications may be made to the invention as broadly described herein without departing from the overall spirit and scope of the invention.

Dated this 15th day of NOVEMBER 1999

WILLIAM RODGERS and

ANTHONY KHOURI

By their patent Attorneys

WALSH & ASSOCIATES

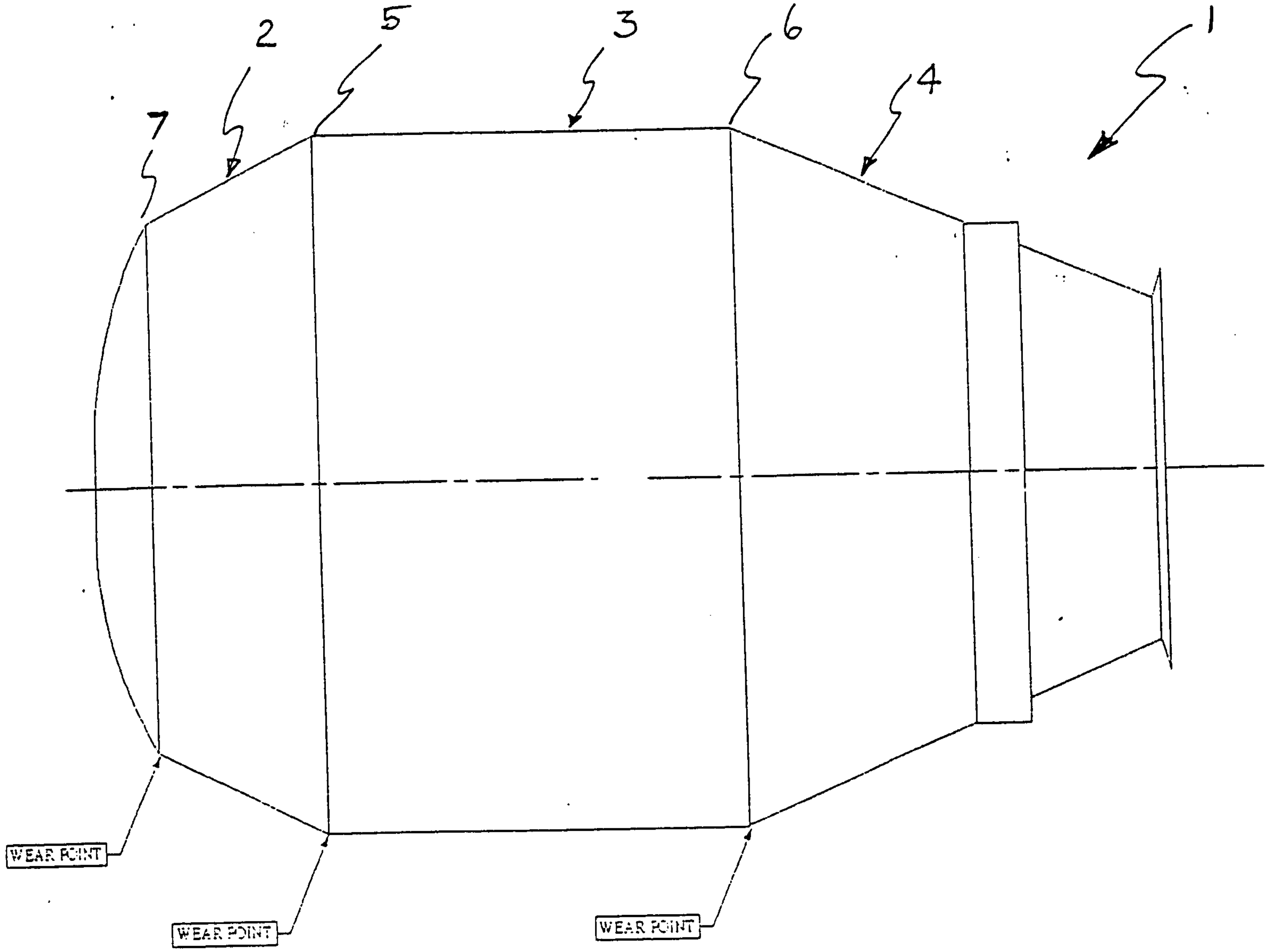

FIGURE 1

DRAWING TITLE	CONCRETE MIXER			
DRN C.S.M	APPD	REV C.S.M	DRAWING NUMBER	REV
DATE 21/4/98	DATE	DATE 21/4/98	FIG No 1	0

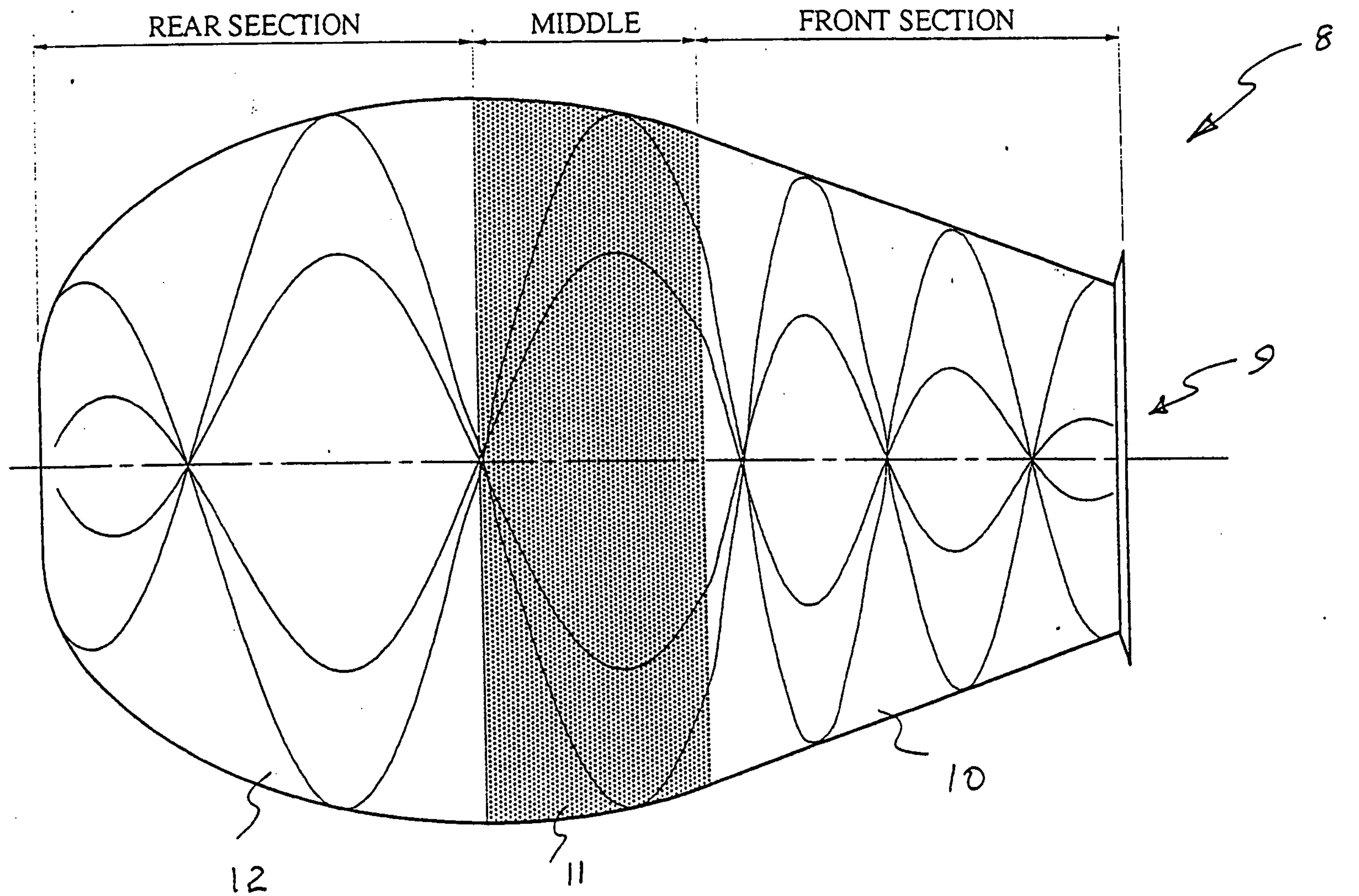

FIGURE 2

CONCRETE ELASTOMERIC AGITATOR

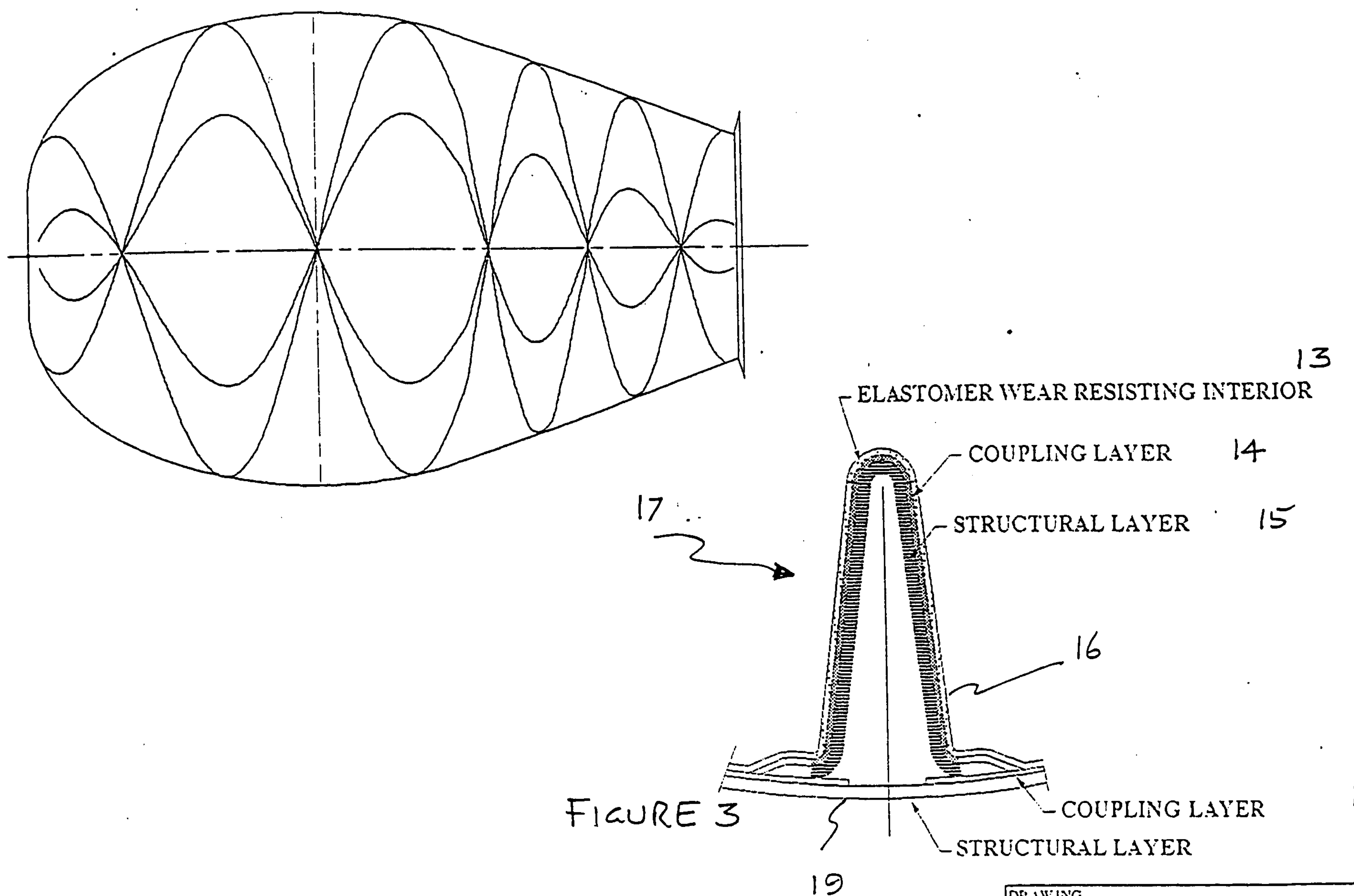

FIGURE 3

DRAWING TITLE	CONCRETE MIXER			
DRN CSM	APPD	REV CSM	DRAWING NUMBER	REV
DATE 21/4/98	DATE	DATE 21/4/98	FIG No 3	0

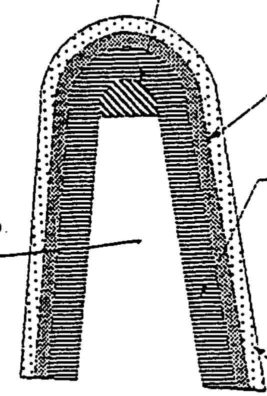

FIGURE 4

DRAWING TITLE	CONCRETE MIXER			
DRN CSM	APPD	REV CSM	DRAWING NUMBER	REV
DATE 21/4/98	DATE	DATE 21/4/98	FIG No 4	0

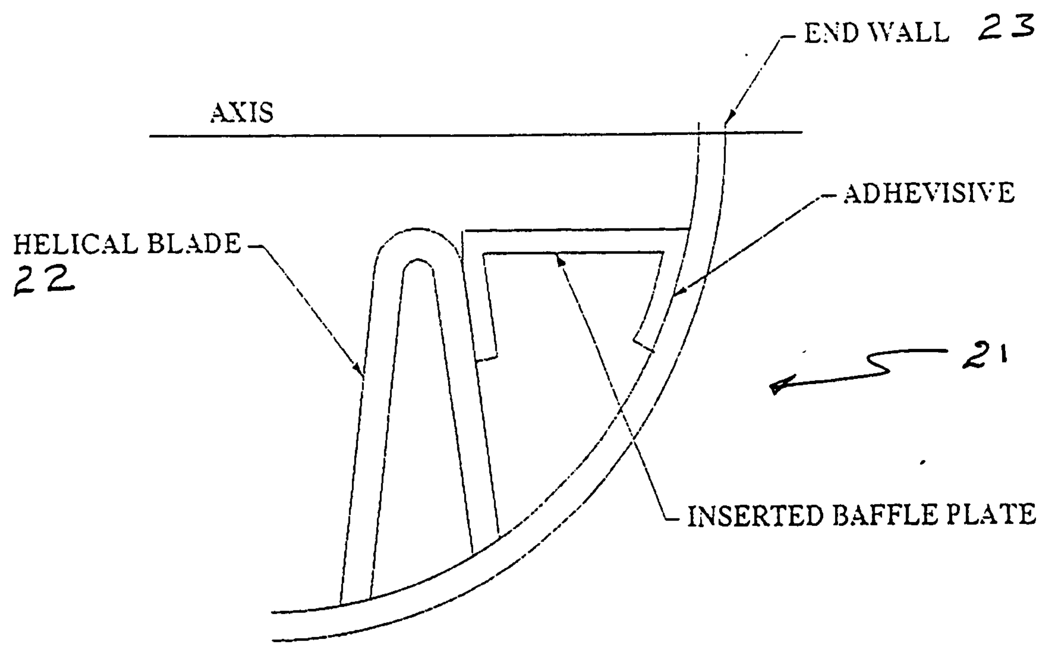

FIGURE 5

DRAWING TITLE	CONCRETE MIXER			
DRN C.S.M DATE 21/4/98	APPD DATE	REV C.S.M DATE 21/4/98	DRAWING NUMBER FIG No 7	REV 0

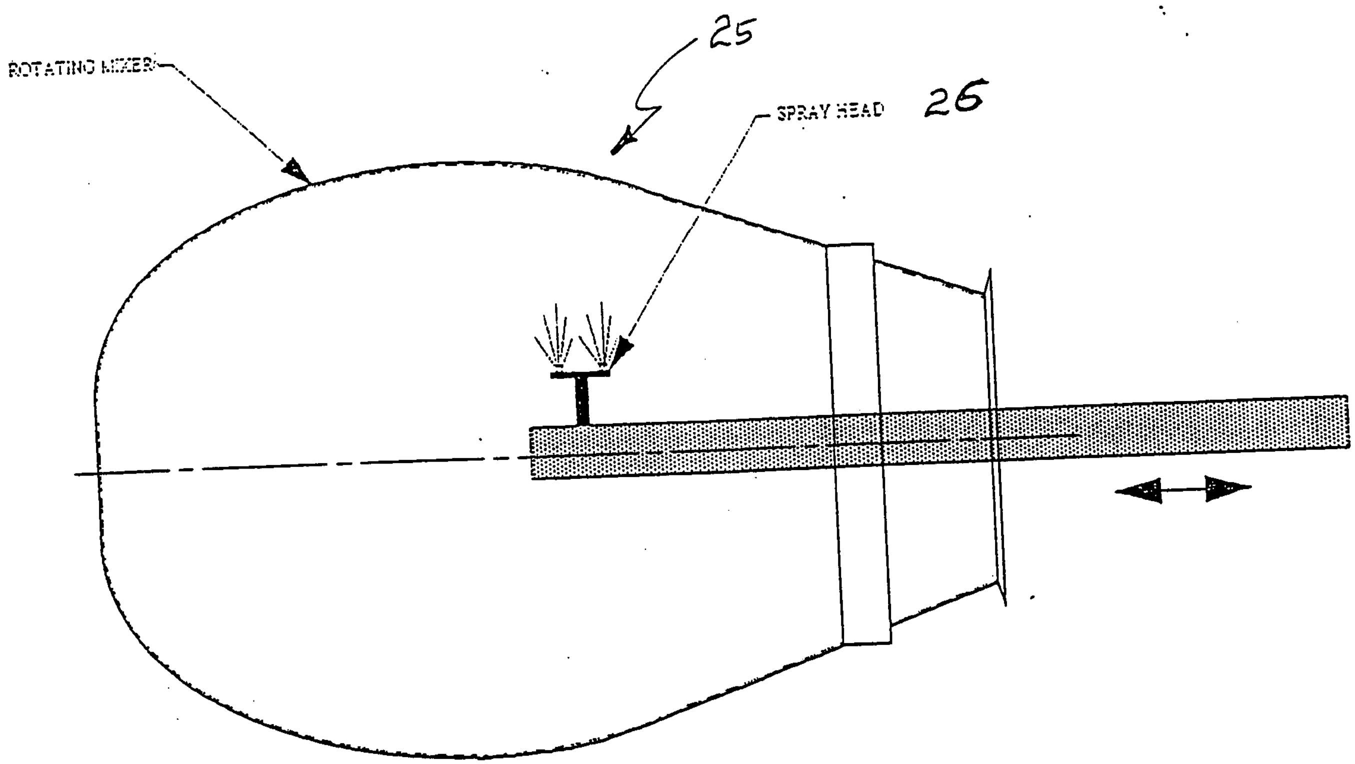

FIGURE 6

DRAWING TITLE	CONCRETE MIXER			
DRN C.S.M DATE 21/4/98	APPD DATE	REV C.S.M DATE 21/4/98	DRAWING NUMBER FIG No 6	REV 0

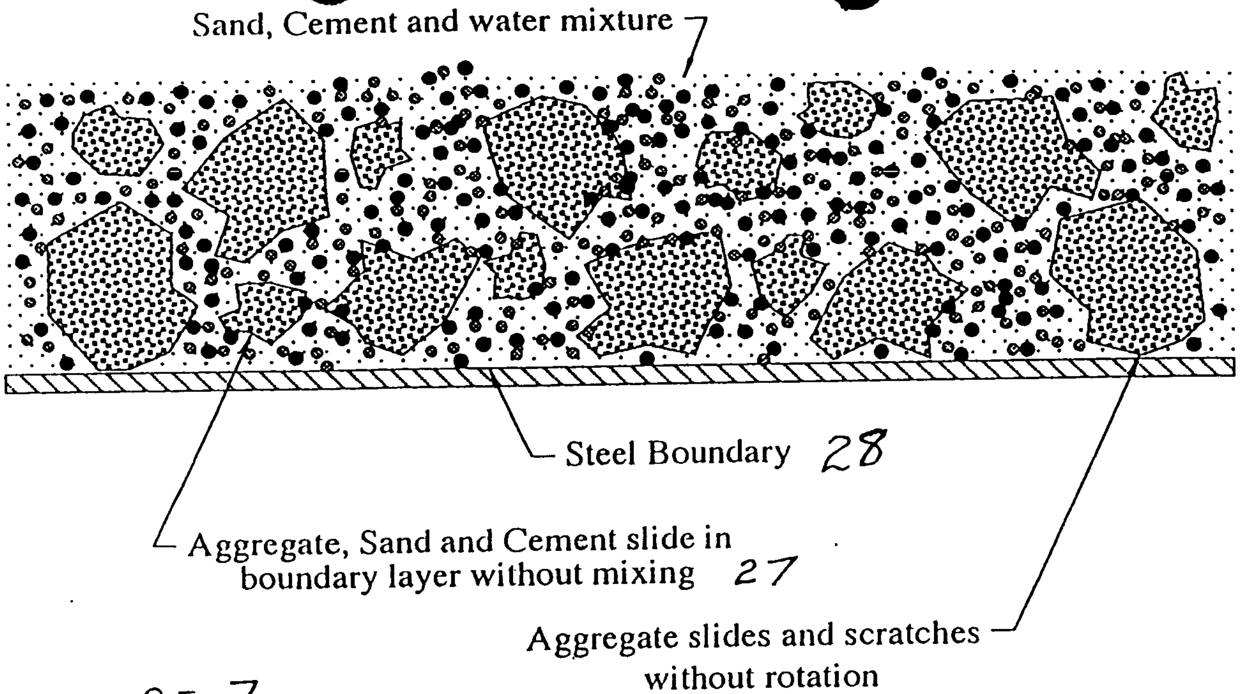

FIGURE 7

CONCRETE MIXING IN STEEL VESSEL

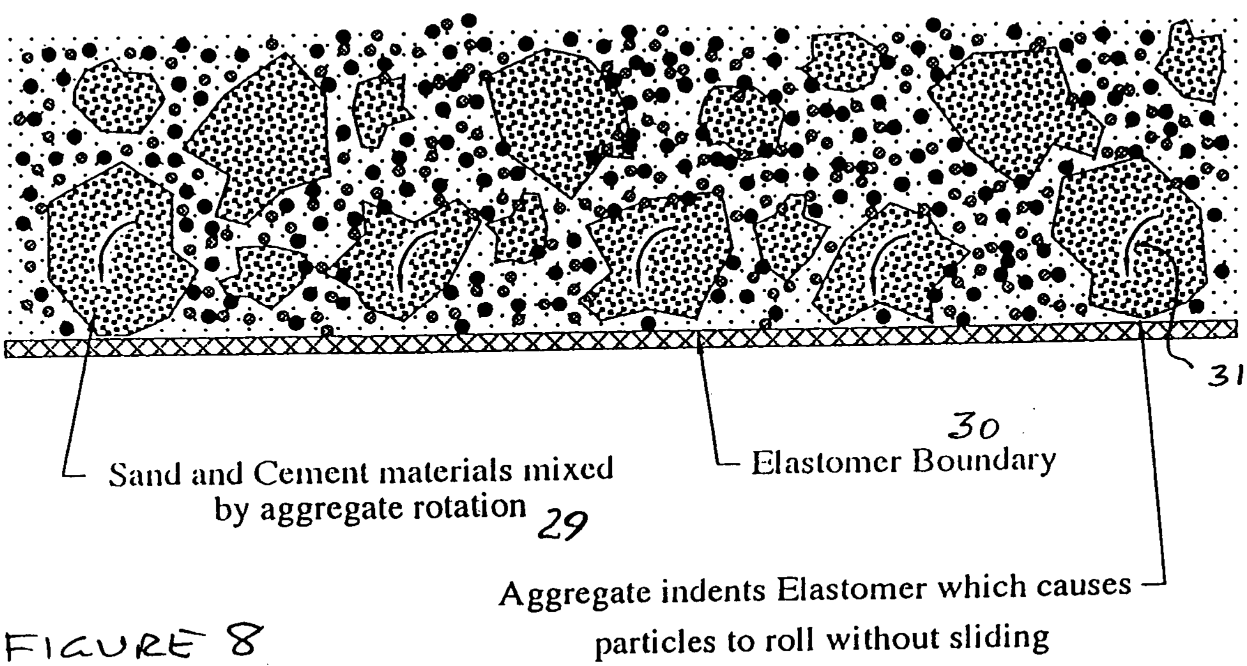

FIGURE 8

CONCRETE MIXING IN ELASTOMERIC VESSEL